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SOME EXPERIMENTS IN QUANTITATIVE MEASUREMENT OF LANDSCAPE QUALITY

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SOME EXPERIMENTS IN QUANTITATIVE MEASUREMENT OF LANDSCAPE QUALITY

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The purpose of this series is to encourage the earliest possible dissemination and discussion of research results. Appearance of a paper in this series does not preclude later formal publication in journals or elsewhere. The authors welcome comments and reactions.

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SOME EXPERIMENTS IN QUANTITATIVE MEASUREMENT OF LANDSCAPE QUALITY

I. INTRODUCTION

The earlier papers in this series have been concerned with the question of landscape quality, as measured by the preferences of observer groups. Coughlin and Goldstein, in The Extent of Agreement Among Observers on Environmental Attractiveness (Regional Science Research Institute Discussion Paper Series: No. 37), investigated levels of agreement among observers, in preference ratings assigned to several series of pictured landscapes. They concluded that there are substantial statistical grounds for the assumption that certain landscapes will be preferred over others.

The authors of the present paper, working from the same set of photographic and field experiments which had been discussed by Coughlin and Goldstein, analyzed the objective characteristics of the landscapes involved, in order to discover which of these characteristics could be said to have a positive or negative influence upon preference ratings. (Rabinowitz and Coughlin, Analysis of Landscape Characteristics Relevant to Preference, RSRI Discussion Paper Series: No 38).

The present study is the third in this series of pilot projects. Working from the findings of the earlier two papers, the authors have attempted to quantify some of the relationships between preference ratings assigned to landscapes and the specific characteristics of those landscapes. We have also attempted an assessment of the relative validity of several different methods of investigating landscape quality: in particular, we have sought to discover which of two experimental methods involving photographs of landscapes comes closest to reproducing the results of experiments involving landscapes themselves.

Since the various groups of subjects who participated in these experiments were both small and homogeneous, we cannot claim any universal validity for our conclusions; but we do feel that these conclusions have pointed out some very interesting directions for future research.

Table 1

CHARACTERISTICS OF THE EXPERIMENTS

Experiment	Number Respondents	Number Sites	Environmental Display
A. Fifteen stream sites in and around Philadelphia			
On-Site Observations	10	15	site visit
Follow-up to On-Site Observations	10	15	2 slides for each site visited earlier by the respondents; shown two at a time.
Group Slie Presentation	8	14	1-3 slides for each of the sites (total of 39 slides) projected one at a time.
Home Interviews	18	14	2 slides for each site, shown two at a time on slide viewers.
B. Countryside in Bucks and Montgomery Counties, Penna.[1]			
Consistency Test	11	14	1 slide for each site, shown one at a time with hand viewer.

[1]The "Consistency Test" is described more fully in Coughlin and Goldstein, "The Extent of Agreement Among Observers on Environmental Attractiveness," RSRI Discussion Paper Series: No. 37, February 1970.

II. THE LANDSCAPE DISPLAYS

Some of the major characteristics of the experiments described in this paper are presented in Table 1.

The basic landscape display used in all the experiments consisted of 15 sites on the banks of small streams in the vicinity of Philadelphia. Five of these sites were located in a densely developed suburban area near the city limits, 5 in a somewhat less dense suburban area, and 5 in open farm country about 20 miles from the city. Twelve of these sites were located either in parks or in residential areas, with roads or houses clearly visible from the chosen observation points; the other 3 were in fields, or sheltered by tress from most signs of civilization. The majority of the sites were wooded, but none of them could be classified as completely "natura.."

In one of the experiments described below, these sites were actually visited by the subjects. (This experiment is referred to in this paper as the "On-Site Observations"; in the two earlier papers it is called the Field Test.) In the other three experiments, subjects were shown from one to three color slides of each site. These slides were taken on or near the

same day on which the first group of subjects visited the sites; they were selected from a larger group of slides so as to provide as complete a representation as possible of the major features of each site.[1] Unfortunately, we were not able to achieve a completely adequate representation of several of the sites, because of the poor quality of the available slides.

[1] "Major features" were identified primarily with reference to the written comments of the subjects in the On-Site Observations.

III. THE EXPERIMENTS

The small size and the homogeneity of the subject groups in these experiments have already been noted. The size, particularly in the On-Site Observations, was dictated by logistics: it was necessary that the whole group visit each site at the same time of the same day, in order to eliminate as far as possible variations in the stimuli due to transitory weather conditions. Under these circumstances, the homogeneity of the groups (subjects for all experiments were women between the ages of 25 and 50, primarily upper-middle-class suburban housewives) was also necessary to the validity of the analysis. Unless the sample of subjects in an experiment such as this is very much larger than any of the samples which we were able to obtain, any great degree of heterogeneity in background, age, or other characteristics is likely to result in an amount of variation due to individual differences which is large enough to obscure the differences between the stimuli themselves.

On-Site Observations

Ten subjects took part in this experiment. All were white, upper-middle-class housewives, and all but one were mothers of school-age children. All had been invited to participate in the

experiment through personal contact with the wife of one of the researchers.

The experiment took place on three consecutive days in early September of 1969. Subjects were driven to each of the sites in a group, by two employees of the Regional Science Research Institute. Five sites were visited on each day; each visit lasted between 30 minutes and one hour. At each site, subjects were seated at a predetermined observation point on one bank of the stream, and asked to fill out a two-page questionnaire.

This questionnaire asked for a brief "objective description" of the site, plus preference ratings on 14 rating scales and 15 "semantic differential" scales. On the rating scales, a score of "1" represented "dislike very much" and a score of "5" represented "like very much"; the semantic differential scales, which also ran from 1 to 5, involved a choice between pairs of descriptive adjectives. The first three questions on the questionnaire, referred to in this paper as the "basic preference" questions, were as follows:

A. Assuming you could have any type of house you wanted in this setting, how would you like to live here?
B. How would you rate this site as a place to pass through and enjoy the scenery?
C. How would you like to use this site for recreation?

The results of this experiment are analyzed fairly thoroughly in the earlier paper by Rabinowitz and Coughlin. Here we are concerned with them only as they relate to the results of the three other experiments discussed in this paper. These experiments, all of which involved photographs of the original 15 sites, were designed to provide further information on the determinants of landscape quality, as well as on the validity of the research method itself. We wished to discover just how closely preference ratings for the sets of slides would correspond to preference ratings for the sites themselves, and whether the same landscape features which seemed to influence preference in the On-Site Observations could also be said to influence preferences for the slides.

Follow-Up to On-Site Observations

The subjects in this experiment were the same ten women who had previously participated in the On-Site Observations. This second phase of that experiment took place approximately six weeks after the first. It was conducted, not by the original researcher, but by one of the ten subjects, who visited the other nine subjects in their own homes. The landscape display consisted of two slides representing each of the 15

sites -- one view upstream from the observation point and one view downstream. These slides were shown to the subjects, two at a time, by means of a small hand-held rack; the order in which they were shown was the same as the order in which the sites had originally been visited.

The subjects were allowed to view each pair of slides for as long as they wished. They were instructed to rate the sites, as they remembered them (rather than the slides), on a scale of 1 to 5 in response to five questions. These were:

1. How well do you remember this site?
2. How attractive is this site overall?
3. Assuming you could have any type of house you wanted in this setting, how would you like to live here?
4. How would you rate this site as a place to pass through and enjoy the scenery?
5. How would you like to use this site for recreation?

Questions 3, 4, and 5 in this experiment are the same as the three "basic preference" questions in the questionnaire for the On-Site Observations.

Before these interviews were conducted, the interviewer herself filled out an identical questionnaire, rating the fifteen sites on the basis of her own memories and the slides.

Group Slide Presentation

The subjects for this experiment were members of a small suburban community-action group. Again, their participation was obtained through personal contact, the president of the group being an acquaintance of one of the researchers. Twelve members of the group, all women, took part. Their ages, education, and other socio-economic characteristics were somewhat more varied than those of the participants in the On-Site Observations, a fact which may account for the relatively low levels of agreement observed in this experiment (see below, p.17); but almost all of these subjects still fell into the general category of "suburban housewives."

Four of the questionnaires in this sample had to be discarded in the analysis, because subjects had answered none, or only a few, of the questions, or had given the same rating to all the slides. This left us with only eight -- a regrettably small but nonetheless usable sample.

The landscape display consisted of 39 slides -- one to three for each of the fourteen stream sites. (The 15th site had to be dropped from the sample in this and the following

experiment, because no adequate slides of it were available.) The slides used were occasionally different from those used in the Follow-Up to the On-Site Observations, first because some of the latter were too underexposed to be used successfully with the available projector, and secondly because it seemed that a different selection of slides would in some cases give a more complete representation of the actual sites. Unfortunately, the final set of slides still contained a few which, when projected onto a screen under the given lighting conditions of the experiment, turned out to be excessively dark. Before the experiment began, the slides were thoroughly shuffled to achieve a random ordering.

The experiment itself was carried out at a regularly scheduled meeting of the subject group, in the home of one of its members. Before the slides were shown, the researcher described the background and nature of the study, explaining that the purpose was simply to discover what people liked or disliked about landscapes in general and streams in particular. Each subject was then given a questionnaire, and instructed to rate each slide on a scale of 1 to 5 in response to three questions which were printed at the top of each page of the

questionnaire -- the same three "basic preference" questions which had been asked in the On-Site Observations and in the Follow-Up. The questionnaire also asked for six items of personal information dealing with such characteristics as age, education, and regional background.

A small projector[1] was used to project each slide onto the screen for a period of 30 seconds. The total time for the experiment was approximately 40 minutes.

Home Interviews

The third slide experiment, like the Follow-Up to the On-Site Observations, was carried out as a series of individual interviews. Eighteen subjects participated. Three of these were recruited through classified advertisements, and were interviewed in the offices of the Regional Science Research Institute; the other fifteen were recruited through personal contact with the wife of one of the researchers, and were interviewed in their homes. All were housewives and mothers; all but one were residents of suburban areas. None had

[1] Sawyer's Projector/Viewer, Model 439-M1; 120 volts AC, 100 watt maximum, CEA/CDK lamp.

participated in the earlier experiments, but as a group they were remarkably similar in all identifiable social and economic characteristics to the ten subjects in the On-Site Observations.

Most of the slides used in this experiment had been used in the Group Slide Presentation; the use of slide viewers[1] allowed two additional slides to be used which were too underdeveloped for use with a projector. The images which were produced by the viewers were about 2" by 3", and of a very high degree of clarity. Two slides, exhibited simultaneously on two slide viewers, represented each site; the order in which these slides were presented was the same as the order in which the sites had originally been visited by the participants in the On-Site Observations.

The 15 subjects who were not interviewed in the Regional Science Research Institute offices were visited by the researcher, over a period of about two weeks. In most cases, two subjects were interviewed simultaneously, two being the maximum number that could look at the two slide viewers at the same time in comfort. The slide viewers were placed on a table or coffee

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[1] see footnote, preceeding page; this model may be used either as a viewer or as a projector.

table, with the slides in order in the racks, and the subjects were shown how to change the slides themselves. They were allowed to look at each pair of slides for as long as they wished before going on to the next. Total time for the experiment was usually between 20 and 30 minutes.

Before the interview began, the researcher gave a brief explanation of the project, similar to the one given to the subjects in the Group Slide Presentation. The only difference was that the subjects in this test were explicitly instructed to rate the site represented by each pair of slides, rather than the artistic quality of the slides themselves. The questionnaire used was the same as in the Group Slide Presentation, except that "slide group" was substituted for "slide" in the instructions, and space was provided for only fourteen sets of ratings. The questions and the rating procedure were the same as in all previous experiments.

IV. ANALYSIS OF RESULTS: AGREEMENT AMONG SUBJECTS AND AMONG EXPERIMENTS

Before the data obtained in these experiments were analyzed, they were first normalized. The purpose of this procedure is to eliminate variation between individuals which is regarded as extraneous, while still retaining each individual's relative evaluations of the various slides. The normalization procedure eliminated differences between mean ratings for observers, for example, between the person who sees everything as either "wonderful" or "terrible", and the person who confines his judgments to the middle range of "moderately good" or "moderately bad" -- and the person who simply doesn't like anything. The formula used was as follows:

$$z = 10\frac{(x-\bar{x})}{s} + 50$$

x = rating assigned by a given judge to a given slide

$\bar{x}$ = mean of all ratings by a given judge in a given test

s = standard deviation of all ratings by a given judge in a given test

Application of this formula results in a uniform mean score of 50 and a uniform standard deviation of 10 for each subject.

Agreement among Subjects: Analysis of Variance

One-way analyses of variance, using individual slides, slide groups or sites as treatment groups, were performed for all sets of normalized scores. Such an analysis indicates the amount of agreement between subjects on preference ratings; it is formally identical to the R^2 measure for "percent of variance explained" by the landscapes. The results of these analyses are given in Table 2.

In the first two experiments, the On-Site Observations and the Follow-Up, the levels of agreement between subjects are similar to those reported by Coughlin and Goldstein for a series of experiments using photographs and slides.[1] Here, as in that series of experiments, the landscapes which constituted the environmental display accounted for approximately half of the total variance in normalized scores, at a very high level of significance. The lowest level of agreement between subjects inthese two experiments occurs in the Follow-Up, in response to Question 2, "How attractive is this site overall?" This question seems to nave engendered some confusion among the subjects of this experiment: mean preference ratings for

[1] Coughlin and Goldstein, The Extent of Agreement Among Observers on Environmental Attractiveness, Section I-B.

"How attractive is this site overall?" show very low correlations with, for instance, mean preference ratings for "How would you rate this site as a place to pass through and enjoy the scenery?"

The levels of agreement in the other two experiments, the Group Slide Presentation and the Home Interviews, are significantly lower. The highest percent of variance accounted for by the landscapes in these two experiments is 44% on Question A in the Home Interviews; in most other cases, individual landscapes seem to account for only about one third of total variance. When the 39 slides used in the Group Slide Presentation are grouped by locations, the percent of variance accounted for by these groups falls to between 10% and 17% -- approximately one third of the variance accounted for by individual slides.

In contrast, Coughlin and Goldstein, in a similar but much more extensive "Locational Character Test", found that 337 slides accounted for 53.6% of the total variance in normalized scores among 11 subjects, and that when these slides were grouped by location, those locations accounted for 36.1% of total variance, or 67.3% of the variance accounted for by the individual slides.[1]

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[1] Coughlin and Goldstein, op. cit., pp. 34-37.

Table 2

PERCENT OF VARIANCE EXPLAINED BY LANDSCAPES, FOR ALL EXPERIMENTS

Experiment and Question	Treatment Group	Sample Size	% of Variance Accounted for by Landscapes	F Ratio	Significance Level
1. On-Site Observations	15 streams	10 subjects			
A. "How would you like to live here?"			48.79%	9.168	$p < .001$
B. "How would you rate this site as a place to pass through and enjoy the scenery?"			52.69%	10.741	$p < .001$
C. "How would you like to use this site for recreation?"			53.51%	11.101	$p < .001$
2. Follow Up	15 streams	10 subjects			
1. "How well do you remember this site?"			51.97%	10.435	$p < .001$
2. "How attractive is this site overall?"			38.80%	6.113	$p < .001$
A. "live"			45.20%	7.952	$p < .001$
B. "pass through"			45.05%	7.902	$p < .001$
C. "use for recreation"			51.06%	10.061	$p < .001$
3. Group Slide Presentation - Individual Slides	39 slides	8 subjects			
A. "live"			35.17%	3.896	$p < .001$
B. "pass through"			43.19%	5.458	$p < .001$
C. "use for recreation"			34.52%	3.785	$p < .001$
4. Group Slide Presentation - Locational Means	14 slide groups	8 subjects			
A. "live"			12.88%	3.888	$p < .001$
B. "pass through"			17.95%	5.016	$p < .001$
C. "use for recreation"			13.03%	3.448	$p < .001$
5. Home Interviews	14 slide groups	18 subjects			
A. "live"			44.44%	14.644	$p < .001$
B. "pass through"			33.94%	9.408	$p < .001$
C. "use for recreation"			36.93%	10.722	$p < .001$

The lower percentage of variance accounted for by locations in this test can be explained partially by the wide variation in slide quality within several locational groups -- underexposed slides tended to receive uniformly low ratings.

Part of the explanation for the low levels of agreement in the Group Slide Presentation experiment could be the differences in background and socio-economic characteristics among the subjects. But this explanation would not hold for the similarly low levels of agreement in the Home Interviews experiment; and in any case, the subjects of the experiments conducted by Coughlin and Goldstein exhibited a wider range of personal characteristics than the subjects of any of the experiments discussed in this paper.

The explanation may actually lie in the nature of the questions which were asked. The high levels of agreement reported by Coughlin and Goldstein occurred in those experiments in which subjects were asked to rate slides simply on the basis of "abstract attractiveness." When the questions were focussed instead on the actual use of the pictured sites -- "How would you like to live here?" and "How would you rate this site as a place to pass through and enjoy the scenery?" --

the percent of variance in scores which was accounted for by the slides fell to about 35%, approximately the same level of agreement as in our Group Presentation and Home Interviews experiments. It will be remembered that all the questions asked in the series of experiments discussed in this paper, except for Questions 1 and 2 in the Follow-Up, concerned various types of use of the sites. The low levels of agreement among subjects in the Group Presentation and the Home Interviews, then, would support the conclusion of Coughlin and Goldstein, that conceptions of use and enjoyment of landscapes differ between individuals more than do conceptions of abstract attractiveness.

If this interpretation is accepted, then the high levels of agreement between individuals in the On-Site Observations and Follow-Up experiments need to be accounted for. There are several possible explanations. Some of the sites were characterized by obvious non-visual disamenities, such as loud car noise, which most of the subjects mentioned in their comments but which could not be reproduced in the context of a slide show. Furthermore, the circumstances of the On-Site Observations allowed subjects to talk to each other during and between

site visits, and there was consequently more opportunity for each subject to be influenced by her neighbors' expressions of appreciation or dislike than in the Group Presentation or Home Interviews experiments.

There was no apparent pattern among the results of the different experiments, as to which of the three "basic preference" questions elicited the highest levels of agreement. Subjects in the On-Site Observations agreed most on Question C; Group Presentation subjects on Question B; and subjects in the Home Interviews on Question C.

Agreement among Experiments: Correlations between Sets of Locational Ratings

Since one of the major aims of this series of experiments was to discover how well photographs can represent the real world, it was important to find out how closely ratings for the sets of slides in the photographic experiments were correlated with ratings in the On-Site Observations, as well as how closely the various sets of photographic ratings were correlated with each other. Table 3a gives the correlations between the set of ratings for each of the three "basic preference" questions on each experiment and the sets of ratings for the same question

on every other experiment. For example, row 1 is concerned with the On-Site Observations experiment and the Follow-Up experiment. In the first column is the correlation coefficient for the ratings on Question A which resulted from each of these two experiments. Columns 2 and 3 contain the corresponding coefficients of correlations for Questions B and C.

The highest correlations in this table, as might be expected, are those between the three sets of mean ratings on the On-Site Observations and the corresponding sets of mean ratings on the Follow-Up (Table 3a, Row 1). These correlations all higher than .85, are roughly similar to those obtained by Coughlin and Goldstein on the "Consistency Test", in which a group of subjects rated a set of photographs, and then rated the same photographs again, one month later.[1] One might expect the correlation coefficients in the present set of experiments to be somewhat lower, considering that the subjects in the On-Site Observations and the Follow-Up were responding to very different stimuli in the two experiments. These high correlations provide a strong confirmation of the hypothesis that preference ratings are the result of enduring and consistent preference patterns, and not merely dependent upon transitory whims.

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[1] Coughlin and Goldstein, op. cit., Section IIB-5

In contrast, none of the correlations between locational means for the On-Site Observations and locational means for the Group Slide Presentation (a "locational mean" in the latter experiment is the average of normalized mean ratings for all slides representing a particular location) are statistically significant as can be seen in row 2. In the case of Question B, there is no correlation at all. This lack of correlation is probably the result of the wide variations in slide quality within locational groups. As is clear from Table 2, Row1, differences between locational groups accounted for only about one third of the total variance accounted for by slides; hence the locational means evidently were more strongly influenced by slide quality than by true locational character. It is also possible that the instructions given the subjects in the Group Slide Presentation placed too much emphasis on rating the slides themselves, as opposed to the sites which they were supposed to represent.

The subjects in the Home Interviews were explicitly instructed to rate the <u>site</u> represented by each pair of slides. The correlations between location ratings for this experiment and location ratings for the On-Site Observations are significant in all cases, ranging from .57 for Question A to .74 for Question

B (Table 3a, Row 3). The high correlations found between the results of these two experiments might seem to indicate the superiority of the Home Interviews method of testing landscape preferences, in which two slides were presented at once, over the method of presenting slides one at a time in random order. There are, however, so many other possible reasons for the low correlations between scores for the Group Slide Presentation and scores for the On-Site Observations, that this conclusion cannot yet be taken as definite.

The highest correlation between locational ratings for the On-Site Observations and those for the Home Interviews is found on Question B, "How would you rate this site as a place to pass through and enjoy the scenery?" It is to be expected that a photograph would represent the general attractiveness of a site better than its desirability for living or recreation, since the latter two qualities would depend more on non-visual factors and subtle factors of status and "atmosphere" than the former.

Table 3b gives the correlations between mean location ratings on the three "basic preference" questions, <u>within</u> each of the four experiments. All correlations are quite high,

Table 3a

CORRELATIONS BETWEEN MEAN LOCATION RATINGS ON THREE "BASIC PREFERENCE" QUESTION,[1] OVER ALL EXPERIMENTS

Correlation between:	Question A "live"	Question B "pass through"	Question C "use for recreation"
1. On-Site Observations and Follow-Up	.895	.854	.894
2. On-Site Observations and Group Slide Presentation	.454*	-.060*	.268*
3. On-Site Observations and Home Interviews	.573	.737	.630
4. Follow-Up and Group Slide Presentation	.379*	-.253*	.095*
5. Follow-Up and Home Interviews	.495	.718	.610
6. Group Slide Presentation and Home Interviews	.672	-.138*	.256*

* = not significant at $p < .05$

Table 3b

CORRELATIONS BETWEEN MEAN LOCATION RATINGS ON THREE "BASIC PREFERENCE" QUESTIONS[1] WITHIN EACH EXPERIMENT

Experiment	Correlations between: Questions A & B	Questions A & C	Questions B & C
1. On-Site Observations	.824	.965	.849
2. Follow-Up	.893	.931	.931
3. Group Slide Presentation	.733	.879	.838
4. Home Interviews	.774	.842	.961

[1]Basic Preference Questions:

A How would you like to live here?

B How would you rate this site as a place to pass through and enjoy the scenery?

C How would you like to use this site for recreation?

the lowest being .82 and the highest .97. These high correlations indicate that the subjects in these experiments did not discriminate very drastically between the "aesthetic" and "use" aspects of the sites. The highest levels of correlation between ratings on the three questions occur on the Follow-Up to the On-Site Observations (Table 3b, Row 2). In all experiments, the correlation between ratings for Question A,

"How would you like to live here?" and ratings for Question B, "How would you rate this site as a place to pass through and enjoy the scenery?" is the lowest of the three -- an indication that the characteristics desired for a residential setting may be different from those which are desired purely from an aesthetic or recreational viewpoint.

V. ANALYSIS OF RESULTS: RELATIONSHIPS BETWEEN PREFERENCE RATINGS AND MEASURABLE CHARACTERISTICS OF LANDSCAPE QUALITY

Selection and Measurement of Characteristics

One of the experiments using photographs described by Coughlin and Goldstein, the Consistency Test, involved ratings and comments by a group of employees of the Regional Science Research Institute on 14 photographs of natural landscapes.[1] These same photographs were later analyzed extensively,[2] in order to discover which elements or characteristics of the landscapes were related to high or low preference ratings. It was found that the five highest-scoring photographs differed from the five lowest-scoring ones with regard to a number of objective characteristics. The "high" photographs were alike in that they tended to show parklike, or man-influenced, scenes; they were neither particularly spacious nor particularly secluded; and they tended to have a higher variety of elements, textures, and colors than the "low" photographs.

In the present study we have proceeded from the conclusions of the earlier papers, to derive objective measures of "photographic quality". These measurements were applied to the

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[1] Coughlin and Goldstein, op. cit., Section IIB-5.

[2] Rabinowitz and Coughlin, op. cit., Section C2.

fourteen Consistency-Test photographs, and the results were used to derive regression equations with normalized mean preference ratings as the dependent variables. These equations, in which six objectively measurable characteristics were shown to be significantly related to preference, encouraged us to apply the same methods to an analysis of the slides used in the Follow-Up, the Group Slide Presentation, and the Home Interviews.

It should be kept in mind that these multiple regression analyses all involve extremely low numbers of degrees of freedom. Although this fact is taken into account in the tests of significance, nevertheless, having this few degrees of freedom is highly undesirable. The reasons for this is the estimates are highly sensitive to values of variables for individual observations, so that a large error component in a single observation can have a major effect on the regression results. Thus, the results should be viewed with extreme caution. They are published in spite of these limitations since the study is admittedly an exploratory one and because the levels of significance are unusually high.

The six "quality characteristics" which proved to be significantly related to preference ratings for the Consistency Test

photographs are listed below. For all measurements of "area", a transparent plastic grid of ¼-inch squares was used for the photographs; when the same measurements were applied to slides, the slides were projected onto a small screen covered by a similar grid. Other measurement techniques are explained in the following descriptions of the six "quality characteristics".

1. Variety of Elements. Hypothesis: a high variety of elements in a photograph will be associated with high preference . Measure: a number of different element categories in photograph, each of which covers a total area of at least two ¼-inch grid squares. Element categories were defined in terms as simple and intuitively obvious as possible: trees, bushes, streams, mowed grass, high grass, clouds.

2. Variety of Brightness. Hypothesis: high variety of brightness will be associated with high preference. Measure: this variable proved to be more difficult to measure than the last. Elwood Shafer, in a similar experiment,[1] used a photometer to measure precise light intensity for each ¼-inch grid square; he then calculated the difference between the value

[1] E. Shafer, Jr., J. Hamilton, Jr., and E. Schmidt,"Natural Landscape Preferences: A Predictive Model", Journal of Leisure Research, 1969, 1, 1-20.

for each square and the values for the four adjacent squares, and summed over all squares. Budget limitations precluded the use of this method in the present study. The best instrument available to us was a photographic light-meter. Each Consistency Test photograph was placed directly under a strong lamp; the light meter was held ½-inch away from its surface, and moved back and forth across that surface. The "variety" measure was the difference (in units marked on the meter) between the highest and lowest readings obtained for each photograph.

When this measurement was performed for the slides used in this study, a different technique had to be used: measurements were obtained from a 2" by 3" image on the viewing screen of a viewer-projector. Unfortunately, light reflected from the surface of a photograph is bound to be more diffuse than light projected directly through a slide. The result is that a very dark picture, with only a small area of bright sunlight, would score higher, in relation to other slides, when measured from a slide than when measured from a print. This discrepancy is a possible cause of the discrepancy between the various sets of regression results (see below).

3. Size of Largest Tree. Hypothesis: a large tree dominating the photograph will be associated with high preference. Measure: total area covered by largest tree in photograph. This measurement was suggested by a study of the written comments of the subjects in the Consistency Test and the On-Site Observations.

4. Length of Longest View. Hypothesis: an unusually long view in a photograph will be associated with high preference. Measure: estimated distance of longest view, in feet. Distances were estimated independently by two Regional Science Research Institute employees, who then compared estimates and compromised on disagreements. The logarithm of the estimated number of feet was taken. The log scale emphasizes differences between relatively short distances, and correspondingly deemphaises equal differences between longer distances.

5. Spaciousness-Seclusion. Hypothesis: a low score on spaciousness-seclusion will reflect the moderate degree of openness desired by subjects, and will, therefore, be associated with high preference. Measure: absolute value of the difference between the measurement for Variable (4) for

each photograph, and the mean of all measurements for Variable (4). Both a very open and a very secluded site would score high on this measurement.

6. Misfits. Hypothesis: presence of misfits will be associated with low preference. Measure: total area of photograph covered by misfits. A "misfit" was defined as any man-made object not insignificant or obviously attractive.

Several other "quality" characteristics were also measured for use in these equations, for instance; "Variety of Color (Hues)" and "Presence of Water". The fact that all the "High" photographs in the Consistency Test showed open expanses of lawn with scattered shade trees suggested that total area of open space (defined as anything that can be walked on or through without diffic lty), area of mowed grass, or arrangement of open space (unbroken space vs. space interrupted by bushes or trees) might also be important. But none of these measurements turned out to be significantly associated with preference ratings.

The best equation for the 14 Consistency Test photographs is given in Table 4, Column 1. Five of the six "photo quality" characteristics are shown to be significantly related to pre-

ference in this equation, although the sign for X_5, Spaciousness-Seclusion, is not as expected. The multiple R^2 is .93. Substitution of X_2, Variety of Brightness, for X_3, Size of Largest Tree, would reduce the R^2 to .90.

These results provide support for the conclusions reached in our earlier paper, with regard to the landscape characteristics which seem to have an influence on subject preference. The only anomaly is the positive correlation for X_5, Spaciousness-Seclusion. In all other experiments discussed in this paper, this variable shows a negative correlation with preference, consistent with our original hypothesis. Differences between subject groups (the Consistency Test group contained a high proportion of men) or between photograph samples (the Consistency Test sample was biased towards long views over open country, while the majority of the stream sites analyzed here were located in heavily wooded valleys) might account for this discrepancy.

In extending this method of quantitative analysis of photographs to the slides which represented the fifteen stream sites, the researchers introduced several new variables into

the equations. These variables were suggested by a preliminary analysis of the correlations between objective characteristics of the fifteen sites, and the preference ratings of the ten subjects in the On-Site Observations.[1]

7. Actual Open Space. Hypothesis: a large amount of open space will be associated with high preference. Measure: area of "open space" in photograph times measurement for X_4 (Length of Longest View). This measurement provides an index of the actual area of open space at the pictured site.

8. Area of Water in Photograph. Hypothesis: a large area of water in a photograph will be associated with high preference. The majority of the slides used in these experiments showed streams, as opposed to only two of the fourteen Consistency Test photographs; it was, therefore, expected that water would show a more significant relationship to preference for this set of slides than for the Consistency Test. Measure: area of water in each photograph.

9. Area of Frequent Flooding. Hypothesis: a large area of frequent flooding will be associated with low preference.

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[1] Rabinowitz and Coughlin, op. cit., Section C3.

Measure: total area of sand or pebble bars or denuded ground within the stream banks in photograph. This characteristic, which is related to the stability of flow of the stream and hence to the relative urbanization of the watershed, was negatively related to preference ratings in the preliminary results for the On-Site Observations.

10. Number of Visible Rocks. Hypothesis: a large number of rocks will be associated with low preference. Measure: number of rocks greater than one foot in diameter. This measurement was also negatively related to preference in the results for the On-Site Observations.

Results for Individual Slides: Group Slide Presentation

Columns 2 through 7 in Table 4 give the regression equations which were derived, using normalized mean slide ratings for the 39 slides in the Group Slide Presentation as the dependent variables. Although all ten independent variables were used in these equations, the only ones which were found to be significantly related to preference ratings were the six which had been derived from the Consistency-Test analysis.

Table 4

REGRESSION EQUATIONS - PHOTOGRAPH RATINGS, CONSISTENCY TEST; SLIDE SCORES, GROUP SLIDE PRESENTATION

Independent variables (photo quality characteristics)	Consistency Test (14 photos)		Group Slide Presentation (39 slides)						Group Slide Presentation (30 slides)					
			Question A		Question B		Question C		Question A		Question B		Question C	
	Coefficient	Standard Error	Coefficient	Standard Error	Coefficient	Standard Error	Coefficient	Standard Error	Coefficient	Standard Error	Coefficient	Standard Error	Coefficient	Standard Error
X_1 Variety of Elements	4.681	.879					1.661	.730	1.228	.768*	1.964	.919	1.708	.873*
X_2 Variety of Brightness			.743	.310	.984	.347	.971	.281					.780	.373
X_3 Size of Largest Tree	.188	.055							.093					
X_4 Length of View	3.900	.791	9.433	2.688	7.004	3.008	10.354	2.564	4.638	2.092			8.346	.
X_5 Spaciousness-Seclusion	5.891	2.208									-6.387	3.785*		
X_6 Misfits	-5.759	2.007	-.157	.052	-.172	.058	-.132	.047	-.119	.050	-.149	.059	-.141	.052
R^2	.9293		.3699		.3944		.5225		.5359		.3119		.5377	
F Ratio	20.945		7.046		5.005		9.966		6.113		3.929		6.121	
Significance Level	$p < .001$		$p < .001$		$p < .01$		$p < .001$		$p < .01$		$p < .05$		$p < .01$	

* = Significant at $.10 > p > .05$

The first set of three equations (Columns 2, 3, and 4, Table 4) is based on ratings for the whole set of 39 slides. The second three equations (Columns 5, 6 and 7) are based on a smaller sample, excluding nine slides, each of which had been objected to by at least one subject on the grounds that it was "too dark". The elimination of these under-exposed slides is reflected in the significant differences between the two sets of equations.

The most obvious feature of all six of these equations is that the percentages of variance explained by the independent variables (the multiple R^2s) are much lower for this experiment than for the Consistency Test (Column 1). The levels of explanation are slightly higher in the equations for the set of thirty than in the equations for the whole set of thirty-nine, but the significance level of the multiple correlations (the F ratio) is lower in all equations for the smaller sample. These low levels of explanation may be attributable to the relatively low levels of agreement on slide scores for the Group Slide Presentation, to the poor quality of the slides involved, or to other practical difficulties encountered in carrying out the experiment.

It is evident, however, that a few of the variables derived from the Consistency Test analysis remain important in explaining preference ratings for the Group Slide Presentation. X_2, Variety of Brightness, shows up most strongly in the three equations for the whole set of 39 slides (Columns 2, 3, and 4); the positive correlation underlines the unfavorable reaction by this group of subjects to the under-exposed slides most of which scored relatively low on this variable. The other two variables which show persistent strong correlations with preference ratings are X_4, Length of View (positive correlations) and X_6, Misfits (negative correlation). Variety of Elements, Size of Trees, and Spaciousness-Seclusion show up in the equations for the smaller set of slides although at a relatively low level of significance; the negative correlation for "Spaciousness-Seclusion" in the equation for Question B (Column 6, Table 4) is the only serious discrepancy between the equations for the Group Slide Presentation and the equations for the Consistency Test photographs. In general, the equations for the smaller set of slides (which were not so strongly affected by the reactions to the very bad slides) are more similar to the original Consistency Test equation than are the equations for

the set of thirty-nine.

Results for Locational Groups: On-Site Observations and Home Interviews

Table 5 gives the equations which were derived, using site scores as the dependent variables and slide characteristics as the independent variables, for the On-Site Observations and the Home Interviews. The independent variables in these equations are substantially the same as those which were used in the equations for the Group Slide Presentation, except that the measurements have been combined over the two slides selected to represent each site. Thus:

X_1, Variety of Elements; X_2, Variety of Brightness; X_6, Misfits, X_7, Area of Open Space times Length of View; X_9, Area of Frequent Flooding; and X_{10}, Number of Visible Rocks with diameter greater than 1 foot, refer to the average of each of these measurements for the slides in the group;

X_3, Size of Largest Tree, and X_4, Length of Longest View, refer to the highest measurement for each of these variables within the slide group;

X_5, Spaciousness-Seclusion, refers to the absolute value of the difference between the figure for X_7 (Area of Open Space times Length of View) for each group, and the mean of all measurements for X_7 over all slides;[1]

X_8, Area of Water, refers to the average area of water for all slides in the group which showed any water at all. We wanted an approximation for the actual amount of water present at the site, and therefore eliminated from the calculations those slides which were taken looking away from the streams.

In the equations for the On-Site Observations, as in the equations for the Home Interviews, the independent variables were derived from the slides which were used in the Home Interviews -- in other words, the two slides which together provided what we felt to be the best representation of each of the fourteen actual sites.[2] This first set of equations (Columns 2, 3, and 4, Table 5) is quite interesting. We obviously cannot claim that the characteristics of the slides, which were chosen

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[1] Several different measurement techniques were experimented with in deriving this variables; the one described above is the one which produced the highest partial correlations with preference ratings. Since the mean length of view for all slides would be lower than the mean length of view for the highest slides in each pair, it can be inferred that the "most preferred" type of site is probably fairly secluded.

[2] One site had been eliminated from the sample for lack of adequate slides.

many months after the On-Site Observations had taken place, had any causal relationship to the ratings which subjects assigned to the sites themselves. Nevertheless, these equations, which were initially derived merely to provide a basis for comparison with the equations for the Home Interviews, show highly significant correlations between the ratings in the field and many of the slide characteristics.

The percent of variance "explained" by the slide characteristics in these three equations ranges from 67% to a surprising 91%. It must be emphasized that these regressions involve, at most, only eleven degrees of freedom (one of the equations for the Home Interviews data involves only four); but all of these correlations are still significant at $p < .05$, and most at $p < .01$. These equations offer evidence that carefully selected photographs may be able to reproduce many of the characteristics of a site which appear to be strongly related to preference.

Three variables appear as consistently significant in the equations for the On-Site Observations: X_2, Variety of Brightness, X_3, Size of Largest Tree, and X_8, Area of Water. (The negative sign on the correlations with X_2 Variety of Brightness,

Table 5

REGRESSION EQUATIONS - SLIDE GROUP RATINGS, ON-SITE OBSERVATIONS AND HOME INTERVIEWS

Independent variables (photo quality characteristics)	On-Site Observations (15 slide groups)						Home Interviews (14 slide groups)					
	Question A		Question B		Question C		Question A		Question B		Question C	
	Coefficient	Standard Error	Coefficient	Standard Error	Coefficient	Standard Error	Coefficient	Standard Error	Coefficient	Standard Error	Coefficient	Standard Error
X_1 Variety of Elements									-10.054	1.387	-7.290	1.553
X_2 Variety of Brightness	-1.355	.506	-1.774	.381	-2.518	.715	-.820	.155	-3.247	.377	-2.577	.467
X_3 Size of Largest Tree	.215	.075	.244	.051	.241	.069	.091	.018	.259	.034	.186	.041
X_4 Length of View					-15.511	6.367						
X_5 Spaciousness-Seclusion			-14.954	5.519			-7.583	2.145	-28.456	2.726	-21.474	3.137
X_6 Misfits			-4.400	.114			-.336	.030	-.475	.036	-.443	.042
X_7 Area of Open Space times Length of View					.040	.021	.028	.006	.024	.007		
X_8 Area of Water	.139	.063	.206	.042	.101	.053			.222	.026	.208	.029
X_9 Area of Frequent Flooding			.289	.117			-.646	.050	-.295	.049	-.353	.055
X_{10} Number of Rocks > 1 ft. in Diameter							.257	.042	.215	.052	.193	.059
R^2	.6035		.9108		.8216		.9884		.9906		.9781	
F Ratio	5.605		12.137		8.257		73.288		47.328		28.039	
Significance Level	$p < .01$		$p < .01$		$p < .01$		$p < .001$		$p < .001$		$p < .001$	

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unfortunately runs counter to our earlier results, and to our hypothesis that high variety will be preferred; but see above p.31 on measurement).

Regression equations using the same set of independent variables were derived for the ratings on the Follow-Up to the On-Site Observations, but are not reproduced in this table.[1] It was expected that the Follow-Up ratings would be more closely correlated with the measureable characteristics of the slides than would the ratings from the On-Site Observations. The multiple correlation coefficients for the Follow-Up equations, however, were all far lower than the coefficients for the corresponding On-Site Observation equations. Questions A and C on the Follow-Up had r's of .71 and .78 respectively, with Variety of Brightness (-) and Variety of Elements (+); the only significant variables. For Question B, Variety of Brightness (-) is the only significant correlation, with r = .69.

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[1] Actual numbers for these variables were slightly different in cases in which the slides used to represent a site in the Follow-Up experiment were different from those used in the Home Interviews. Measurements and ratings for all 15 sites were used to derive these equations.

In contrast, the equations which were derived for the Home Interviews experiment (Columns 4, 5 and 6 of Table 5) are very similar to those for the On-Site Observations, with an even higher percentage of variance explained by the slide characteristics. In all three of these equations the multiple R^2s are .97 or higher, at an inordinately high level of significance. Furthermore, all but one of the "photo quality" variables are significantly related to preference ratings in at least two of these equations; and only three of these relationships are significant at a lower level of probability than $p < .02$.

This high level of explanation, and the similarity of the equations for Home Interviews ratings and slide characteristics to those for the On-Site Observation ratings and slide characteristics cannot be due simply to the high correlations between the sets of scores for the On-Site Observations and the Home Interviews, since the scores for the Follow-Up experiment were even more closely correlated with those for the On-Site Observations, but showed almost no significant correlations with "photo quality" characteristics. These results are, instead, another indication of the validity of the experimental method employed in the Home Interviews.

A comparison of the equations in Table 5 with the equations given in Table 4 will illustrate this point. Although the significance of the equations for the Group Slide Presentation (Columns 2-7, Table 4) is adversely affected by our difficulties in carrying out the experiment, these equations are nonetheless clearly similar to those obtained for the fourteen photographs in the Consistency Test, and clearly dissimilar to those obtained for either the On-Site Observations or the Home Interviews. It would seem that presentation of two or more slides together, allowing the subjects to take as much time as they wish in making their judgments, tends to elicit a pattern of response which is much more similar to the pattern of response elicited by actual site visits than is the pattern elicited by slides which are presented one at a time. Possibly the experimental method of the Home Interviews encourages concentration on all the aspects and possible uses of a site, while the methods of the Consistency Test and Group Slide Presentation inadvertantly over-emphasize the artistic and compositional qualities of the individual slides themselves.

There are several differences worth mentioning between the equations given in Table 5 and those given in Table 4. X_2, Variety of Brightness, and X_4, Length of Longest View, appear in Table 5 as negatively related to preference. Where they appear in Table 4, the correlations are positive, and indeed, according to our original hypotheses, both of these variables would be expected to show positive correlations with preference ratings.

This discrepancy may be explainable in the light of the differences between the patterns of response to the Home Interviews and the Group Slide Presentation. If the Home Interviews method did indeed emphasize the "real world" aspects of the sites rather than the aesthetic qualities of the slides, then subjects in a "real world" situation evidently prefer a fairly secluded site (short length of view), but not one which is heavily wooded (heavily wooded sites scored highest on X_2, as a result of the measurement technique described on p.31). In addition, the badly under-exposed slides, which scored relatively low on X_2, could be seen more distincly when the slide viewer was used than when the projector was used -- a factor which eliminated in the Home Interviews, much of the negative response

which had been associated with these slides in the Group Slide Presentation.

For both the On-Site Observations and the Home Interviews, the negative correlation for "Variety of Brightness" is lowest in the equation for Question A, "How would you like to live here?" -- an indication that the seclusion provided by thick woods has some positive value in a residential situation.

The characteristics of the desired landscape are further illuminated by the large, and highly significant, negative correlation for X_5, Spaciousness-Seclusion, which appears in the majority of the equations in Table 5. The high significance of this correlation provides added support for the hypothesis that the "generally preferred" type of site conforms to a fairly precise degree of spaciousness, neither too open nor too confining.

In both sets of equations given in Table 5, the correlation coefficient for X_5, Spaciousness-Seclusion, is highest in the equation for Question B, "How would you rate this site as a place to pass through and enjoy the scenery?" It will also be noted that in both sets of equations the level of explanation for Question B is higher than for either of the others, and

that the Home Interview ratings were most highly correlated with the On-Site Observations scores for this question. It would seem that the cultural stereotype of the "attractive landscape" is more clearly defined, and more closely agreed upon, than the conception of a landscape that is useful or liveable.[1]

Most of the other correlations which appear in Table 5 are as expected. There is a positive correlation for X_3, Size of Largest Tree, and small positive correlations for X_7, Area of Open Space times Length of View, and X_8, Area of Water. A negative correlations for X_9, Area of Frequent Flooding, in the equations for the Home Interviews, suggests that some of the effects of urbanization on a stream may be perceived as deleterious. The large negative correlation for X_1, Variety of Elements, in two of these equations (contrary to the direction of correlation expected), suggests the hypothesis that visual complexity high enough to result in visual confusion would be disliked. However, it is doubtful that any of the sites were complex enough to account for such a response.

These equations cannot be interpreted as a "model" of preference patterns, which could be used to predict preferences

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[1]Compare Coughlin and Goldstein, op. cit., Section II-4.

of different subjects for different landscapes. Our samples of both subjects and landscapes have as yet been far too small. But the general consistency of these measurements in explaining these sets of preference ratings convinces us that we have succeeded in uncovering certain very important aspects of landscape quality.

VI. CONCLUSIONS

Although none of the results of this study can be looked upon as definitive, several patterns have emerged which we feel are important enough to warrant further investigation. A few relatively minor points may be mentioned at the outset.

1. Our results support the conclusions of Coughlin and Goldstein, that when subjects are questioned about the possible uses of a site, they tend to agree with each other somewhat less than when questioning is confined to abstract aesthetics. Analysis of these experiments suggests that, when use is in question, landscapes themselves can be expected to account for somewhat less than half of the total variance in normalized scores.

2. Most subjects in these experiments did not seem to discriminate very strongly between the type of landscape in which they would like to live and the type of landscape which they would like to use for recreation. There was slightly more discrimination between the landscapes which were preferred for these two uses and those which were preferred primarily on the basis of aesthetics (Question B, "How would you rate this site as a place

to pass through and enjoy the scenery?")

3. The close correlation between the ratings assigned to the fifteen sites in the On-Site Observations and the ratings assigned to photographs of the same sites in the Follow-Up to the On-Site Observations provides another indication that the preference patterns which are assumed to underlie the actual responses are consistent and enduring.

   The major focus of this study, however, has been on the investigation of significant measurable components of landscape quality, and on the evaluation of the relative validity of different methods of testing landscape preferences. An it is in these two areas that our analysis has yielded its most valuable results.

4. There are definite indications that some aspects of "landscape quality" can be quantified, through objective measurements of photographs if not of actual landscapes. Several of these aspects have been identified in the course of this paper. The size of the largest tree in a photograph seems to be closely related to the degree of preference for that photograph:

whether this relationship is due to a favorable reaction to big trees as such, or merely to the aesthetic effect of a single dominant feature, is unclear. The high negative correlations between preference ratings and the measurement for "Spaciousness-Seclusion" indicate that a fairly private but not confining site will be generally preferred. A large area of water in a picture also seems to have a positive influence on preference.

There are other aspects of landscape quality whose relationship to preference ratings is not so clear. Indeed, several of these factors seem to influence preference in opposite directions, depending on the experimental situation and the questions which are asked. High "Variety of Brightness", for instance, was positively related to preference ratings in one set of equations and negatively in another; in both cases, the correlations were highly significant. The positive and negative correlation coefficients for "Length of View" (Tables 4 and 5, respectively) provide another example.

5. The differences between these correlations may be explainable in terms of the different patterns of response elicited by the various experimental methods employed in this study. There are several indications that responses of subjects to slides will differ in some significant respects from responses to the sites represented by those slides. High variety of brightness and high length of view, considered solely as aesthetic characteristics, may have a positive influence on preference for pictures, but when use and appreciation of actual sites is in question (as in the equations for the On-Site Observations, Table 5), these characteristics seem to be less desirable. Thick vegetation, which is usually associated with high variety of brightness, could be detrimental to recreational enjoyment. A panoramic view, similarly, would be attractive in a picture, and nice to stop and gaze at for a few minutes; but for residential and recreational use, a secluded site might be preferred.

In conclusion, the authors feel that the results of the present series of experiments, while not conclusive in themselves, have provided a useful addition to the small body of landscape perception data which now exists. This study, like the two preceding ones, has been largely exploratory in character. It has provided suggestions as to several specific aspects of landscape quality which seem to warrant further investigation. It has also helped us to make judgments about the relative validity of different experimental methods, and provided illustrations of some of the pitfalls inherent in any investigation in which responses to the real world must be deduced from responses to pictures. We hope that this study will have helped to lay the groundwork for a thoroughgoing analysis of the determinants of landscape quality in the future.

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